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# A web-based learning support to improve students' learning of statistics

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**Keywords**
improve, support, students, learning, statistics, web

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# A Web-based Learning Support to Improve Students' Learning of Statistics

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**Abstract** This study investigating the impact of a web-based learning supports particularly a Headstart program on student outcomes in statistics at the University of Wollongong. Unlike in 2010, a Headstart program was introduced to the undergraduate students enrolled in an introductory statistics subject in 2011. This program allowed students to access the first module of work which includes a set of five lecture notes, video clips, and the first assessment via the subject e-learning site approximately four weeks prior to the start of the formal session. For the assessment, the students were required to complete a draft and redraft the first assignment in the e-learning site. At the end of the session (March/Autumn) in 2011, a survey was also undertaken with the students. In 2011, a one-way ANOVA and Scheffe post-hoc tests revealed a statistically significant difference ($F_{2,192} = 5.301, p = 0.006$) in the mean of the final marks between the students who engaged with the program compared to those who did not. To ascertain the impact of the program, two cohorts of students were examined: the students from 2010 who had not access to the Headstart program, and the students from 2011 who had access to the program including the draft and redraft of assignment. The mean of the final marks in 2011 were significantly higher than in 2010 ($p = 0.004$). Overall, an analysis of student outcomes showed that the students with access to the program including the draft and redraft of assignment performed better in their assessment tasks compared to the students without access. The paper concludes with a discussion on issues in developing the Headstart program with the introductory statistics subject and followed by recommendations for further implementation.

**Keywords** learning support, statistical learning, e-learning, assessment

## 1 Introduction

A very high proportion of students entering higher education in disciplines such as engineering and science are required to enrol in courses that involve mathematical or statistical based content and processes. For more than a decade the decline in mathematical and statistical skills among undergraduates has been apparent even in higher level courses of study across many disciplines [2, 3, 6, 7, 9]. Consequently, a vast number of students experience difficulty and anxiety when learning. This frequently leads to failure of students to complete these mathematics rich subjects in their first attempt. It is a tough situation for students when these subjects are compulsory subjects within their courses of study.

In the learning of statistics, the achievement of students is closely related to their ability in mathematical skills. This has been demonstrated in a study that revealed a significant relationship between student mathematical skills and their performance in an introductory statistics course [4]. Thus it is relevant to highlight the issue of deficit mathematical skills relative to statistical skills in the practice of improving statistics education. To deal with these issues, and in particular to improve mathematical and statistical learning, there is a need to increase reliable, supportive and expert learning support to assist students learning mathematics and statistics across a wide range of disciplines in universities [1, 5]. This study explored the need for learning support embedded in subjects in which students are enrolled. This was distinct from the provision of support through a centre that provides assistance for students from various disciplines in the university.

Frequently, learning support is offered to students when they enrol in subjects such as mathematics and statistics. This support can include additional tutorials, team learning, staff consultation hours, and online learning via learning management system (LMS) [1]. They [1] further

noted that the accessibility of teaching and learning resources available via online to students at times convenient makes this an effective way to address student needs. Furthermore, this form of technology is increasingly being used in the teaching of mathematics and statistics due to decreased numbers of mathematics staff and increased class sizes [8] and increased variation of the students' backgrounds entering the university (e.g. on-campus versus distance students, domestic versus international students). At the University of Wollongong, this form of learning support is also aligned with the graduate quality that promotes self-learning or being an independent learner among students of diverse backgrounds. Distance students are those who are completing their courses at times convenient, live and study anywhere, all at their own pace subject to assessment deadlines but having access to the same online services as on-campus students (refer to http://www.uow.edu.au/future/distance/index.html). International students are generally those who studying in educational institutions of different country from their own either for a short term or long term study programs.

In the context of this study, the phrase 'learning support' refers to subject-specific support provided to students through a web-based e-learning management system. At the University of Wollongong, the e-learning system is known as a Blackboard Learning system. Within this system, all learning resources, tasks, and support materials can be provided to students including lecture notes, Edu-stream (audio recorded lectures), laboratory work or exercises, assessment (assignments, quizzes, tests), worked examples, video resources, laboratory notes, past test and examination papers, and a student forum.

## 2 A Headstart Program

Initiated in February/Autumn 2011 session, a Headstart program was introduced to an introductory statistics subject (STAT131) as a learning support which allows students to start engaging with statistics prior to the commencement of the session. The students accessed the Headstart program through the web-based e-learning system set up for STAT131 in February/Autumn 2011 session. The Headstart was originally conceived of as a program that extended the time students would have to learn statistics. The idea of introducing this new design in the subject was based on the students' experience, which suggested that the thirteen weeks of session allow insufficient time for them to adequately learn and understand the subject. An alternative approach would involve a curriculum review; it was decided to leave the subject objectives the same and to not reduce the content or processes to be learned. The Headstart was an optional program held in four weeks before the session formally commenced in 2011. Some 'within session' tasks and resources were included in the Headstart in addition to alternative tasks and resources.

The increase of failure rate particularly in STAT131 in the previous years flagged the need for improvement of the subject design so as to improve student learning of statistics, hence this was the aim of the study. Consequently, a Headstart program named "Stepping into Statistics" was offered to the students in 2011. It was made available on 2$^{nd}$ February, 2011 and remained available until the 28$^{th}$ when the session commenced.

All resources included in the program such as the lecture notes were accessible through the e-learning site. In this program, students were allowed to access the first module of work in the subject and to complete an alternative first assignment. Each lecture commenced with an activity to address a learning issue and this was followed by activities essentially integrating laboratory work within the lectures. The students who successfully completed the first assessment given in this program were also allowed to skip the first laboratory test assessed in the formal 2011 session. These students were then required to complete the second assessment (i.e. assignment) in a formal session as shown in Figure 1.

### 2.1 Method

Commenced on 2$^{nd}$ February, 2011 the students who enrolled in STAT131 were invited to participate in a Headstart program through the e-learning system. This program was run via online for four week until 28$^{th}$ February, 2011. Ethics approval was obtained from the University of Wollongong Ethics Committee (ethics number: HE09/021) in order to invite students to participate in the

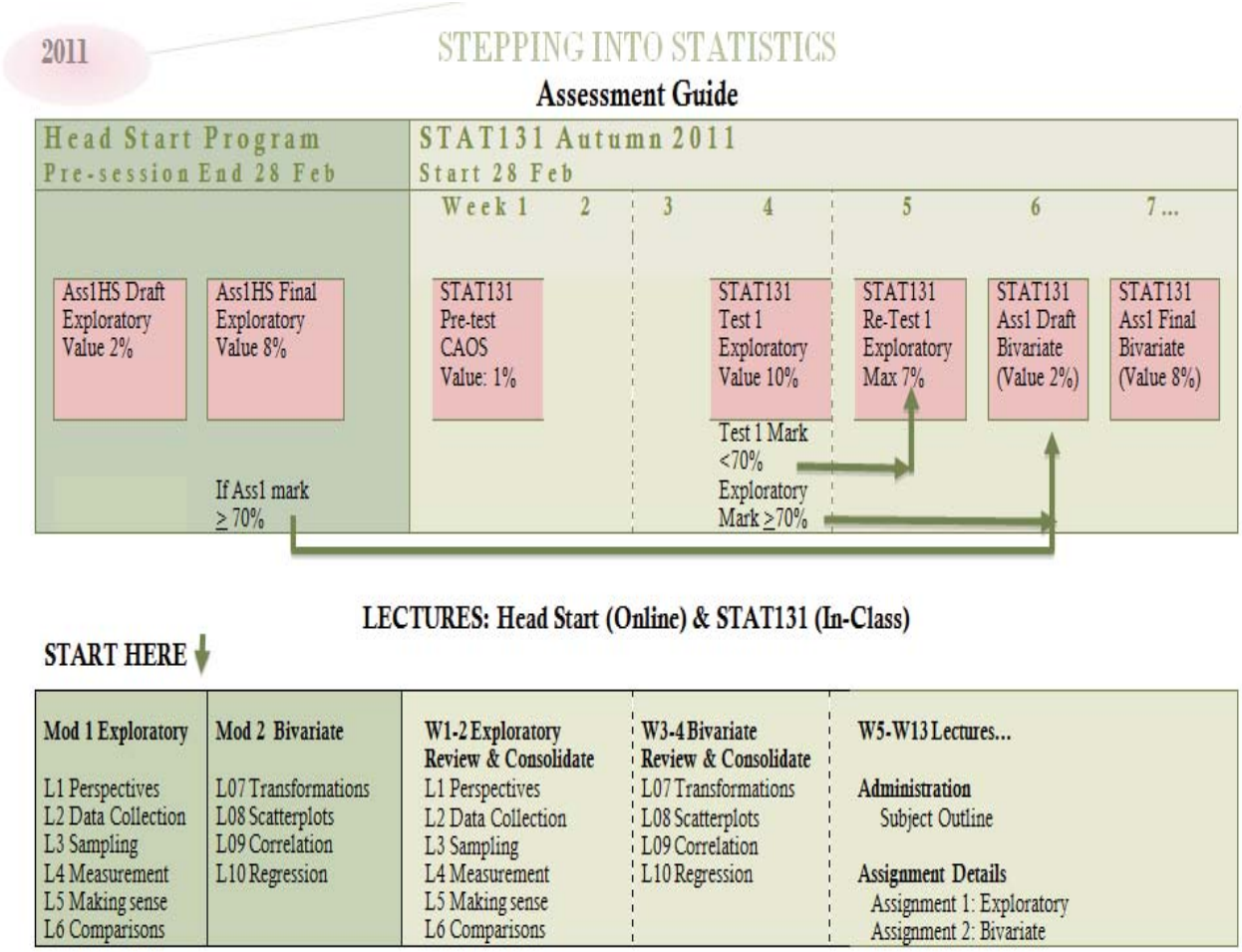


Figure 1: Assessment guide designed for the Headstart program.

investigation of the impact of learning support on student outcomes. The same lecturer taught and co-ordinated STAT131 for both years in 2010 and 2011. With the exception of students having an access to the Headstart program in 2011, all resources were similar for both years but there was a slight modification to the assessment system in 2011. There was one group assessment task involved a draft and redraft of assignment and the other four laboratory tests involved a test retest approach. That is, in a group assessment task, students were asked to prepare a draft of assignment (i.e. video clips) and submit it to the e-learning site. This allows for feedback from other students and the lecturer. Pedagogically, it meant that the students were not put in a position of failing and then taking a retest. This way, all students were provided with feedback that could help them improve their work. The final videos were uploaded in the e-learning site taking into account suggestions and comments based on the draft version submitted earlier (see Figure 2). The students in 2011 were

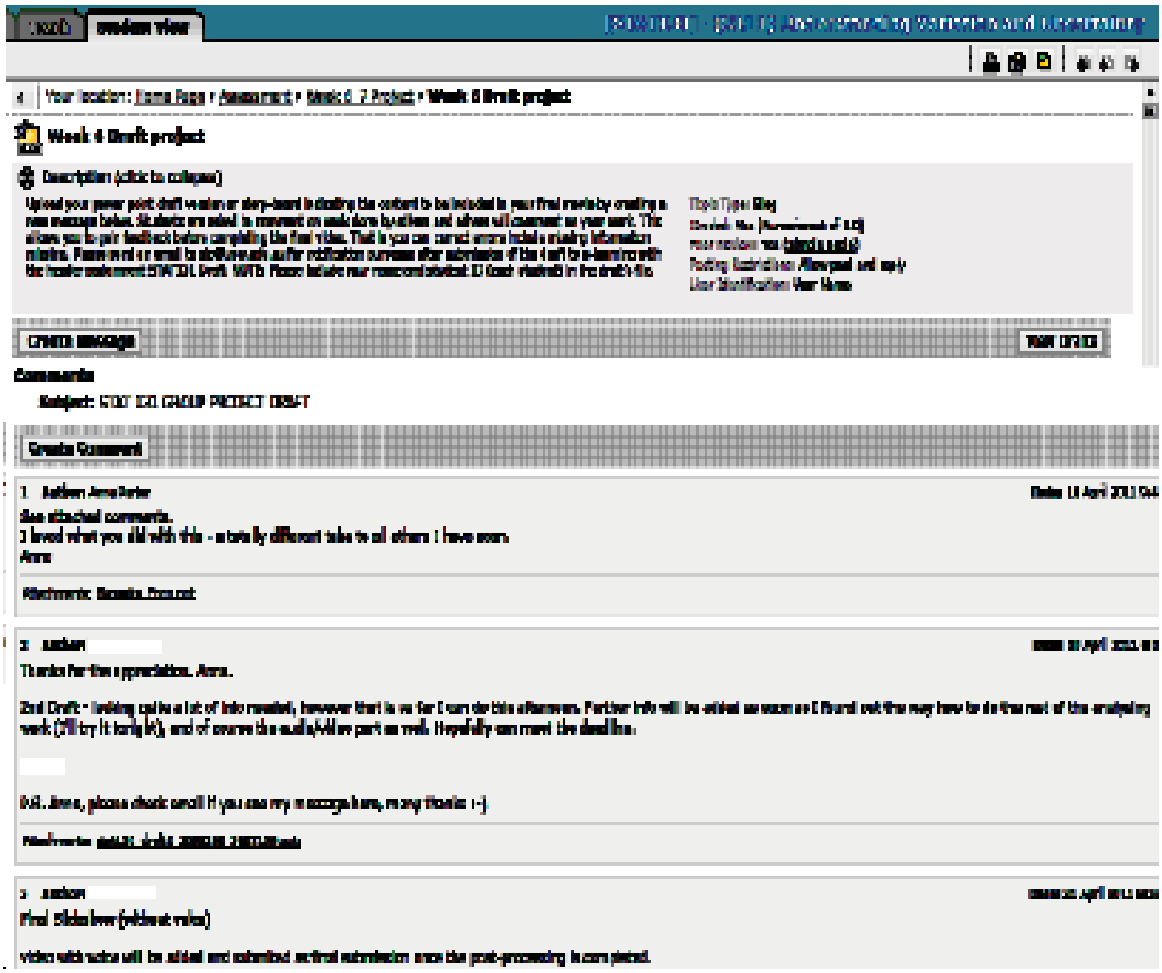

Figure 2: Comments on the draft of assignment in the e-learning site

approached and initially informed about the purpose of the study through a Participant Information Sheet delivered via email. In addition to the information sheet supplied to the students, they were asked to provide a return email or completion of permission slip (consent form) giving their consent to participate in the study. The students were told that their participation was voluntary and that they were free to refuse to participate and to withdraw from the study at any time. The students would not be penalised for not participating in the study and they were informed that the outcome of the study should be beneficial for future students. In 2011, the students completed the online survey at the end of the session through the e-learning system and returned the completed consent form (via email) indicating their agreement to participate in the study. In addition, the tracking of commentaries in student forum and the e-learning student tracking statistics were observed between

2nd February and 31st March, 2011 in order to examine the students' usage of the Headstart resources and activities in the e-learning system.

## 3 Results and Discussion

The Headstart program was introduced to the students in STAT131 March/Autumn 2011 four weeks prior the formal session commenced. There was a set of 5 lectures including video clips, reading materials, and tasks/activities developed for this program. These resources were made available in the subject e-learning site so that the enrolled students could access them via online.

An analysis of student forum as of 1st March 2011 revealed that 11.4% (n = 25) out of approximately 220 students had signalled intent to engage or participate in the Headstart program. These were observed through a prompt asking them to answer a series of questions in the forum, for example "Do you have any concerns about studying statistics?". There were 32% (n = 8) out of the 25 students completed and submitted the draft assignment that was required in the program however 20% (n = 5) did not signal intent to submit an assignment. The students were also asked to provide comments on their draft assignments hence only 20% (n = 5) out of the 25 students took part with a total of 17 commentaries. These commentaries were then used by the students to improve their final assignment. As a result eight students had submitted and of these seven (87.5%) successfully completed at a grade of 70% or better. One student was unsuccessful (but gained 90% in the alternative first assessment in STAT131).

For the purpose of evaluating how useful the program was in supporting student learning in the subject, the students were asked to answer several questions included in the survey. These questions were as presented in Table 1. The findings from the survey revealed that of the 59 responses, 46% of the students (n = 27) did not access the program, 30% (n = 18) were not aware that the program was available, 12% (n = 7) perceived the program useful for them to learn and understand the subject before the session commence, 7% (n = 4) reported that the program was time consuming, and 5% (n = 3) did not provide any response to this question. According to the survey, the proportion of students who completed the program ranged from 17% of the students (n = 10) who completed the draft assignment and had submitted their final assignment to 22% (n = 13) who had undertaken peer review of draft assignment. Approximately, 19% of the students (n = 11) read the lecture notes and/or had undertaken the activities included in the program.

There was no mechanism to advertise the Headstart program to the students. They located it only when they enrolled in the subject and had logged on to their e-learning site. This reflected in the students' comments to the question, "Do you prefer to have the Headstart program in this subject?". Of the 49 responses, 49% (n = 24) preferred to have such program in the subject, 22.4% (n = 11) responded that they were not aware the program was available, 20.4% (n = 10) pointed out other reasons (as noted below), and 8.2% (n = 4) were not interested in accessing the program. The students were asked to indicate whether they prefer to have the Headstart modules in other subjects. Of the 59 responses, 49% (n = 29) indicated that they preferred other subjects to have such programs, 46% (n = 27) indicated that they were not interested, and 5% (n = 3) did not respond. This result suggests that there was a potential for the Headstart program to be developed for other subjects so as to provide opportunities to students to have more time for their learning. Out of the 44 responses, 43.2% (n = 19) were in agreement with the duration of time allocated for the program, 36.4% (n = 16) either agreed or disagreed for some reasons, 11.3% (n = 5) disagreed, and 9.1% (n = 4) remained unsure.

The survey also sought to identify the students' difficulties and problems while taking the Headstart program. Of the 43 responses, 65.1% of them (n = 28) had no issues though some probably did not access the program at all, 30.2% (n = 13) revealed some issues particularly on the awareness of the program in the subject and its benefits for their learning, and another 4.7% (n = 2) were uncertain as they had not accessed the program. Of the 17 responses, 47% (n = 8) recommended that the program should be appropriately advertised so that the students knew of its existence, 41.2% (n = 7) proposed to improve the program, and 11.8% (n = 2) were uncertain.

An e-learning tracking statistics was undertaken between 2nd February and 31st March 2011 to examine the Headstart resources accessed and activities undertaken by the students enrolled in

Table 1: Questions on the use of Headstart program in STAT131

How did you find the Headstart program in this subject?

a. I was not aware the program was available.

b. I did not use them.

c. It was time consuming for me to use them.

d. It helps me learn and understand the subject before the session commence.

Did you participate in the STAT131 Headstart program by ...

- reading the lectures and/or undertaking activities suggested? a. Yes b. No
- completing a draft assignment? a. Yes b. No
- undertaking peer review of draft assignment? a. Yes b. No
- submitting the final assignment? a. Yes b. No

Do you prefer to have the Headstart program in this subject?
a. Yes b. No. Please explain:

Do you prefer to have the Headstart modules in other subject?
a. Yes b. No

Do you think the duration of the Headstart modules is sufficient to get yourself ready in learning and understanding the subject?
a. Yes b. No. Please explain:

Do you have any issues in taking the Headstart program in this subject?
a. Yes b. No. Please explain:

Do you have any suggestions for improvement of the Headstart program in this subject?

STAT131. It was found that 53.3% (n = 104) out of 195 students enrolled in STAT131 downloaded the Headstart online lectures or activities. Among them, 44 students had downloaded 4 to 5 of the available lectures (2 weeks of activities) and an additional of 60 students downloaded 1 to 3 lectures (one week of activities). After 1st March, 2011, 16.9% (n = 33) out of 195 students downloaded the lectures which effectively meant that these students had additional resources rather than resources that could provide them with a Headstart. This left 36.4% (n = 71) accessing the program before the session commenced. It was not possible to ascertain what was done with the lectures or activities once they had downloaded them.

To examine the differences in means of the final marks between the students who engaged with the program (either for all lectures or through accessing 1 to 3 lectures) compared to those who did not, one-way ANOVA and Scheffe post-hoc tests for differences in means between three groups were used for analyses. The result revealed a statistically significant difference ($F_{2,192} = 5.301$, p=0.006) in the mean of the final marks between the students who engaged with the program compared to those who did not. The students who downloaded 4 to 5 lectures achieved significantly higher mean marks of 11 marks better than those who did not engage with the program. Likewise, the students who downloaded 1 to 3 lectures achieved on average of 9 marks higher than those who did not (see Table 2). However, there was no significant difference in the mean of the final marks between those who downloaded 1 to 3 lectures compared to 4 to 5 lectures. One-way ANOVA test was used

Table 2: Comparison of mean of final marks between students who engaged and did not engage with the Headstart program in STAT131.

| | **N** | **Average marks** | **Standard Deviation** |
|---|---|---|---|
| Not engaged | 91 | 62.50[a,b] | 24.09 |
| Downloaded 1 to 3 lectures | 60 | 71.63[a] | 18.17 |
| Downloaded 4 to 5 lectures | 44 | 73.96[b] | 21.92 |
| **Total** | **195** | **67.93** | **22.38** |

[a]The mean difference is significant at p=0.046

[b]The mean difference is significant at p=0.019

to examine the differences in means of final marks between the two cohorts, 2010 and 2011. The result revealed that the 2011 cohort attaining significantly higher mean final marks than the 2010 cohort (p = 0.004) with a mean difference of 8.2 marks (refer Table 3). This indicates that the introduction of the Headstart program and the draft and redraft of assignment in the e-learning site had potentially helped improve student learning outcomes in 2011. It was possible to discern a significant difference in marks due to participation, in terms of accessing the set of lectures and activities for the Headstart program. These have been discussed earlier in the previous paragraph (see Table 2).

Table 3: Comparison of mean final marks between the two cohorts in STAT131

| | **N** | **Average marks** | **Standard Deviation** |
|---|---|---|---|
| March/Autumn 2011[b] | 195 | 67.93[a] | 22.38 |
| March/Autumn 2010 | 191 | 59.73[a] | 23.84 |

[a]The mean difference is significant at p=0.004

[b]Students who engaged with the Headstart program attained average final marks of 71.6 (downloaded 1 to 3 lectures) and 73.96 (downloaded 4 to 5 lectures)

*Note:* Students who did not engage with the Headstart program in 2011 attained average final marks of 62.50 which were marginally higher than in March/Autumn 2010

## 4 Conclusion

In 2011, the introduction of the Headstart program in the subject has allowed students who engaged with the program to complete a draft and redraft the first assignment via the e-learning site. The students who attained marks 70% or above for this assignment were not required sitting the first test or retest. The second assessment was of the form draft/final and the remaining three assessments test and retests. A new direction in the assessment system which allowed students to prepare a draft and redraft of the assignment enabled them to remove a stigma of failure. Pedagogically this approach should be more positive than a test retest approach. However, there were implications for marking of the assessment in the two approaches: draft and redraft of the written assignment taking more marking time with students working with self-selected data than test retest approach which was undertaken on a small range of data sets. There was improvement in the learning outcomes where the failure rate dropped from 18% in 2010 to 13% in 2011 and the students in 2011 outperformed than in 2010 in their final exam. It was also found that the students with access to the Headstart program performed better in their final examination than those who did not engage with the program.

The Headstart program could be improved by having the program available in January rather than early and mid of February 2011, and possibly having the second module of three lectures on bivariate data analysis available as well. Therefore, more students could access it for a greater period of time. Even though new students enrolled in February, later year students could access it in January. The students however could engage with the resources/activities/lectures provided in the program at any point throughout the session and many found this useful.

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